Burnthrough Experiments on OMEGA to Study Effects of Laser-Irradiation Uniformity and Shinethrough Layers on Spherical-Target Performance

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Burnthrough[1] experiments were conducted on spherically imploding capsules containing a buried Si signature layer to study the effects of laser irradiation with multiple-color-cycle 2-D SSD at 0.25 THz on target performance. The targets were irradiated with all of the 60 beams on the OMEGA laser system, and two pulse shapes were studied: a 27-kJ, 1-ns square pulse and a 23-kJ, 1-ns foot to a 2-ns ramp pulse. In addition, the target performance of capsules with an overcoat layer of 1000 Å of Al or 800 Å of Si, defined as a shinethrough layer, is compared with the performance of capsules with no shinethrough layer. Time-resolved x-ray spectroscopy was used to determine the onset of the Si emission, and a suite of neutron diagnostics on OMEGA were used to measure the neutron yield. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC03-92SF19460, the University of Rochester, and the New York State Energy Research and Development Authority.

1. D. K. Bradley *et al*., Phys. Rev. Lett. **68**, 2774 (1992); J. Delettrez *et al*., Phys. Plasmas **1**, 2342 (1994).

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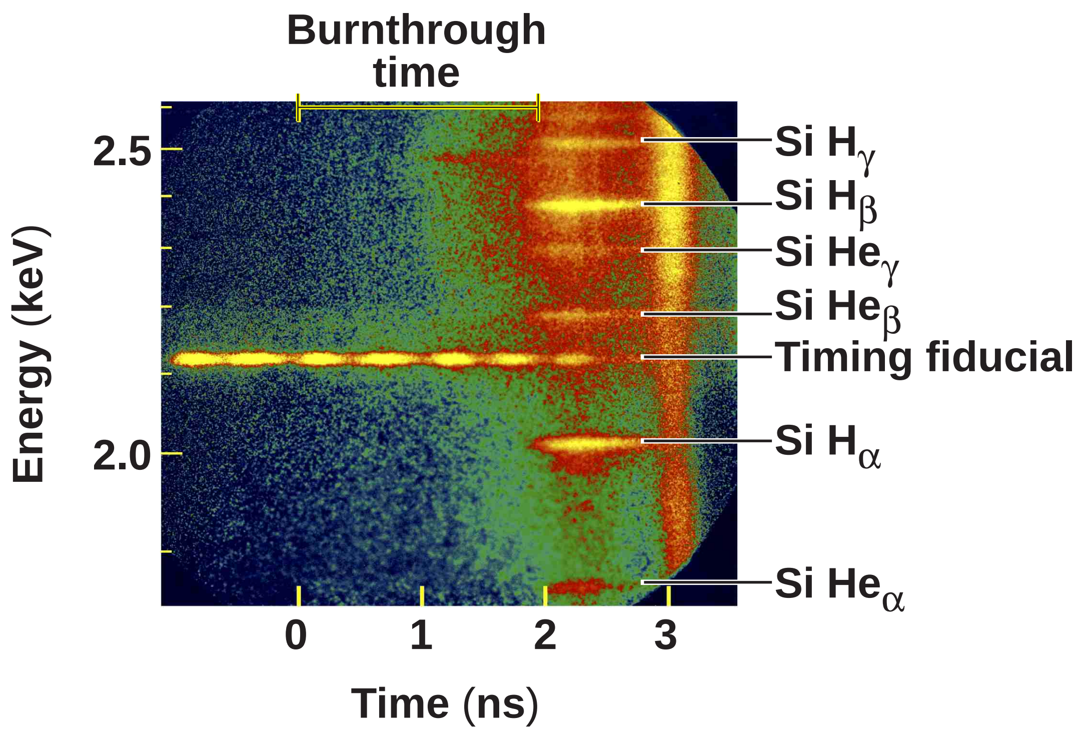

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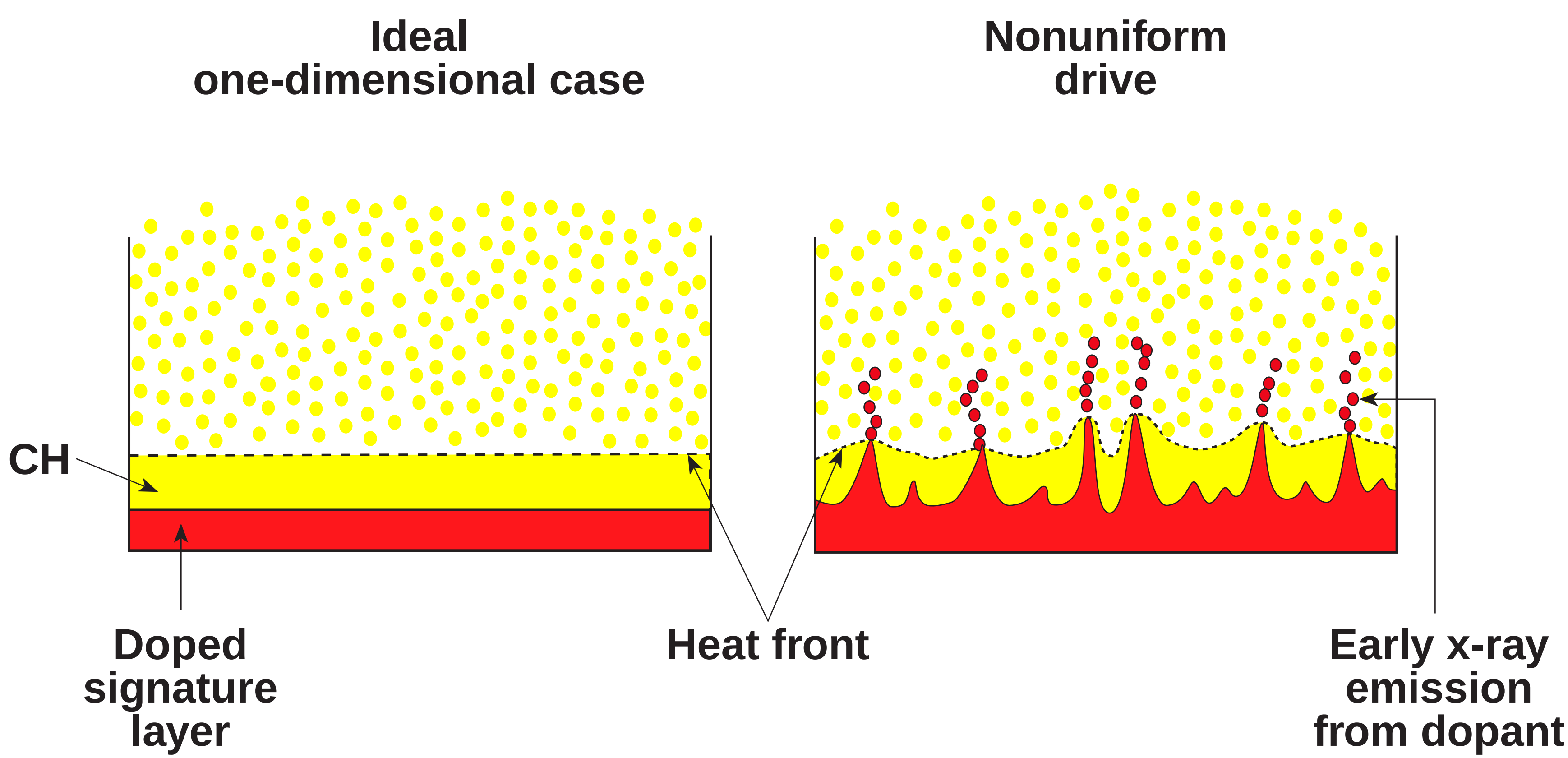
Summary

Burnthrough experiments probe the Rayleigh–Taylor instability in direct-drive implosions

- Capsules containing buried Si-doped signature layers were irradiated with shaped pulses having peak intensities of ~6×10^{14} W/cm^2.
- Onset of Si K-shell emission was measured with time-resolved x-ray spectroscopy.
- Burnthrough was modeled with a multimode postprocessor to a 1-D hydrocode.
- Capsules irradiated with three-color-cycle, 2-D SSD have similar burnthrough to those irradiated with one-color-cycle, 2-D SSD.
- Shinethrough layers on plastic capsules do not affect the burnthrough in a significant manner for the three cases studied: 1000 Å of Al, 800 Å of Si, or no overcoat.

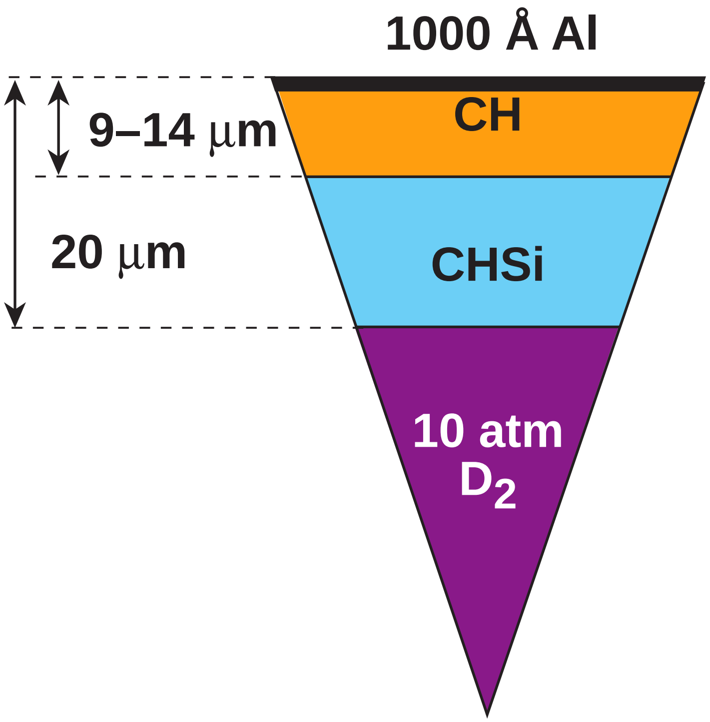
* D. K. Bradley, J. A. Delettrez, and C. P. Verdon, Phys. Rev. Lett. 68, 2774 (1992);
J. A. Delettrez, D. K. Bradley, and C. P. Verdon, Phys. Plasmas 1, 2342 (1994).

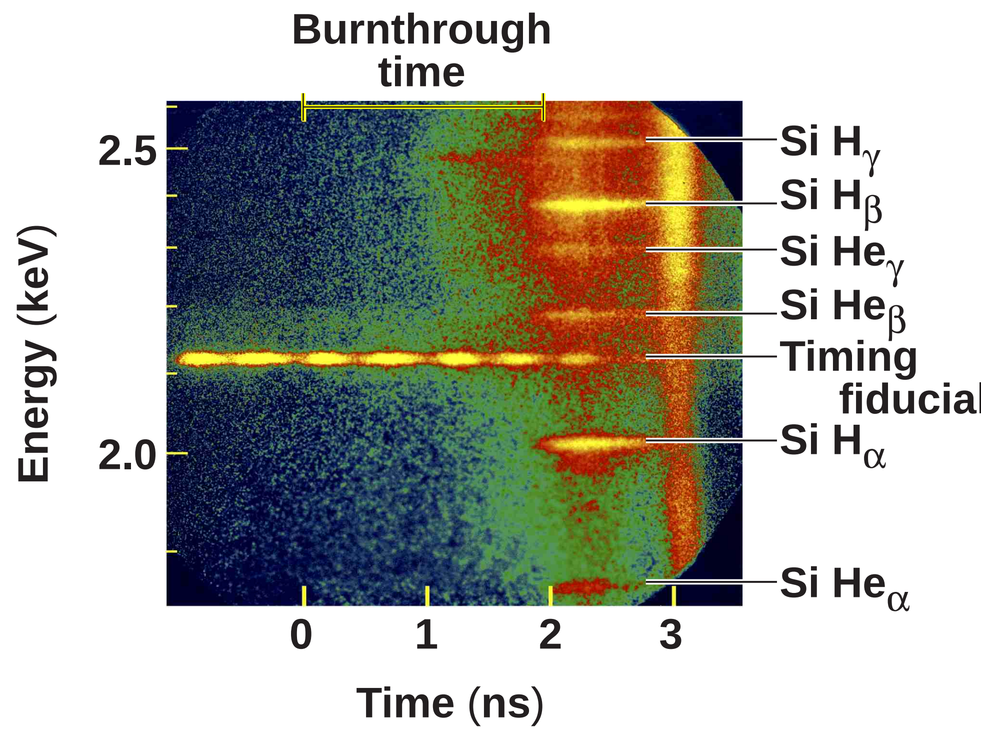
RT instability growth of accelerating shell has been examined using burnthrough technique



E9254

Si K-shell emission from buried signature layer is monitored with streak camera to measure burnthrough





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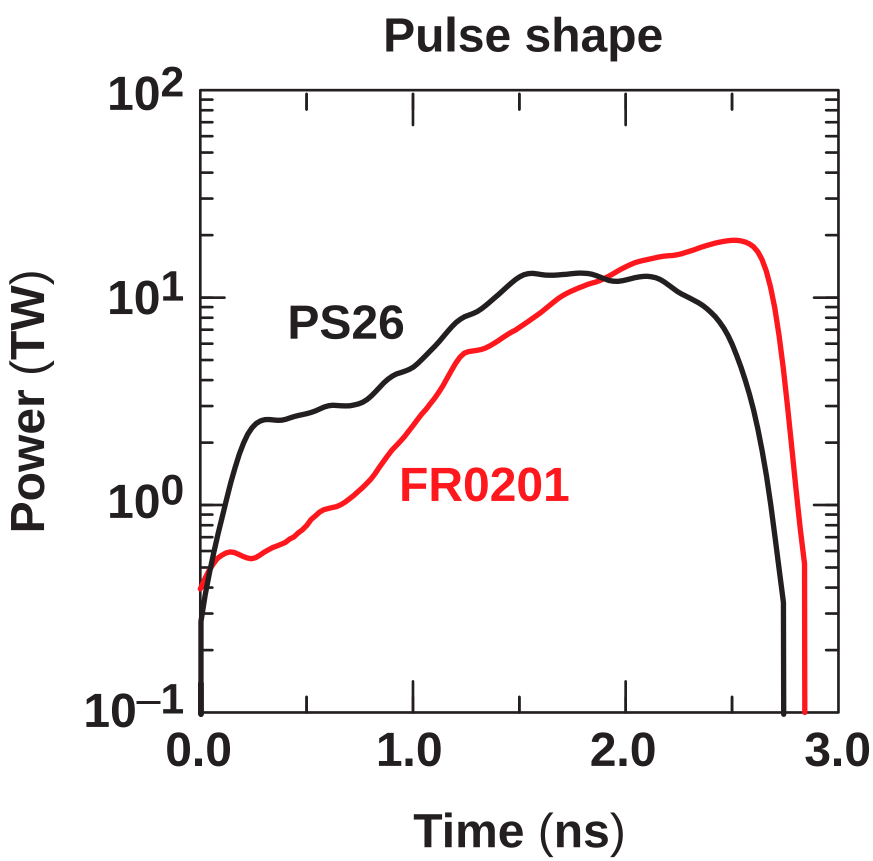
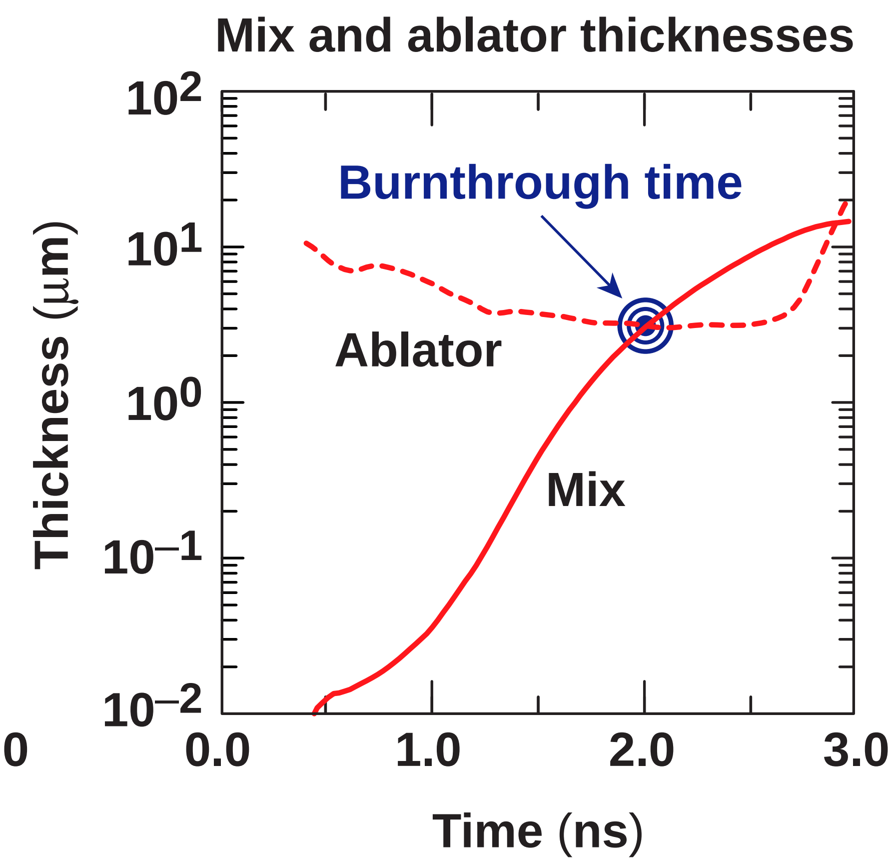
Burnthrough occurs when mix thickness equals the ablator thickness





- **Burnthrough was measured with pulse shapes FR0201 and PS26.**

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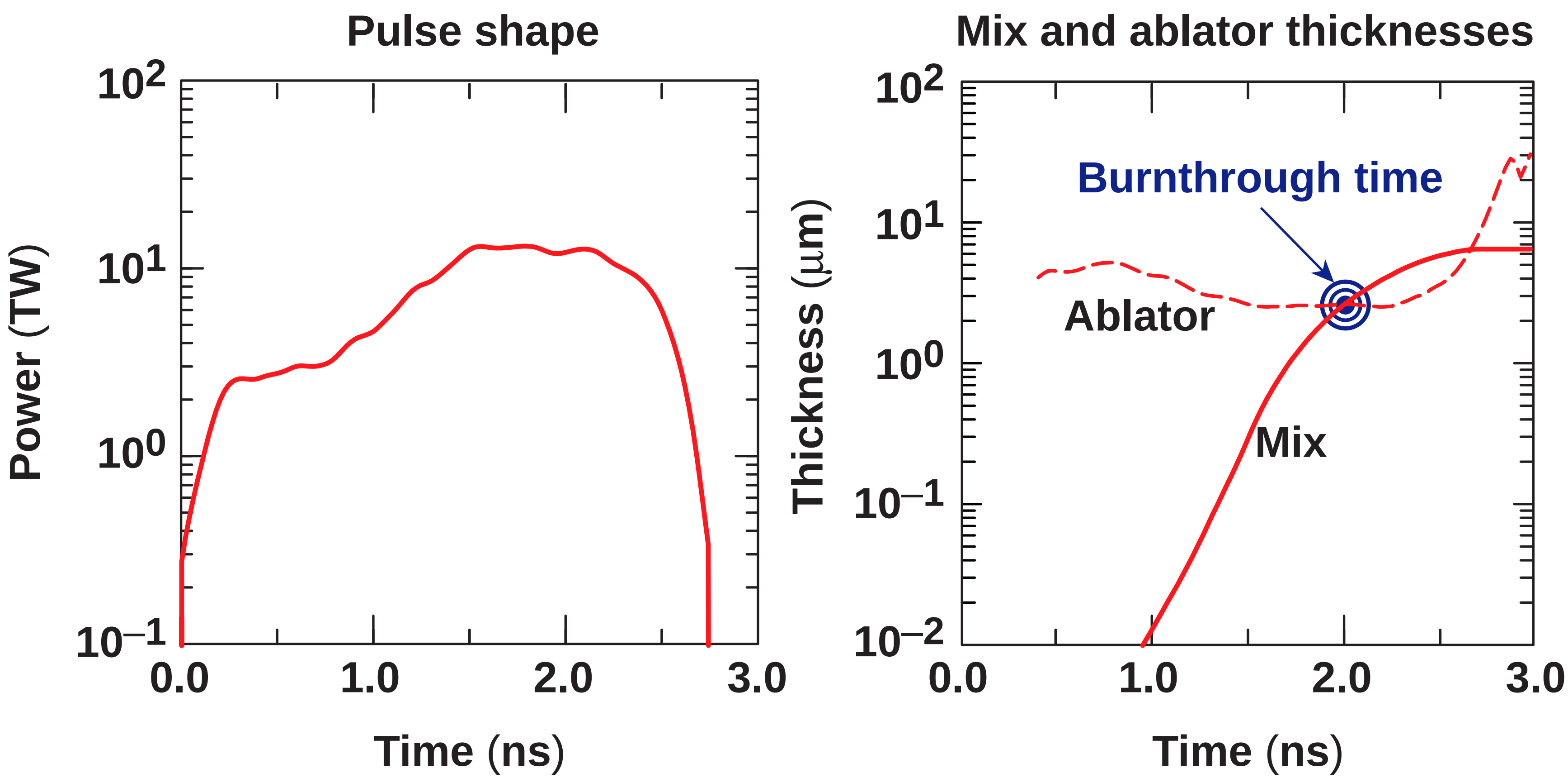
Pulse shape PS26 irradiates the capsule and burnthrough occurs when mix thickness equals the ablator thickness



E10177

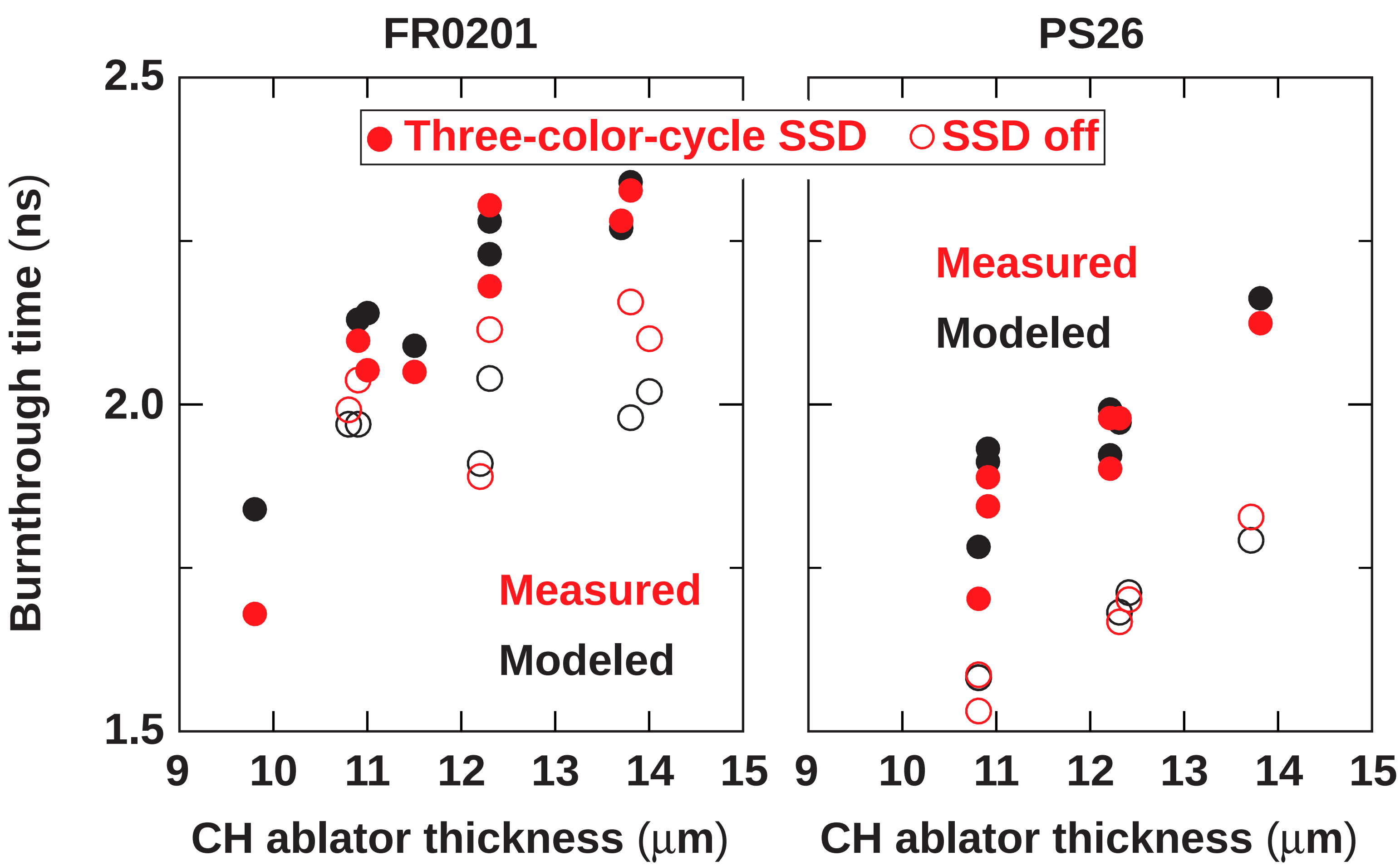
Mixing is calculated using a multimode postprocessor to a 1-D hydrocode

- The initial perturbation spectrum is derived from calculated equivalent-target-plane images.
- Single-mode amplitudes grow using rates calculated from the Betti formula:

$$A_k = A_{0k}e^{\gamma t} \text{ where } \gamma = 0.98\sqrt{\frac{ka}{1 + kl}} - 1.7\ kV_a$$

- Saturation is included using Haan’s model.
- Mix thickness is obtained from rms amplitude summed over all modes $(l < 200)$.

Burnthrough for laser irradiation with three-color-cycle SSD was measured for two pulse shapes



Burnthrough model shows that the laser nonuniformity is reduced by a factor of 4 with SSD.

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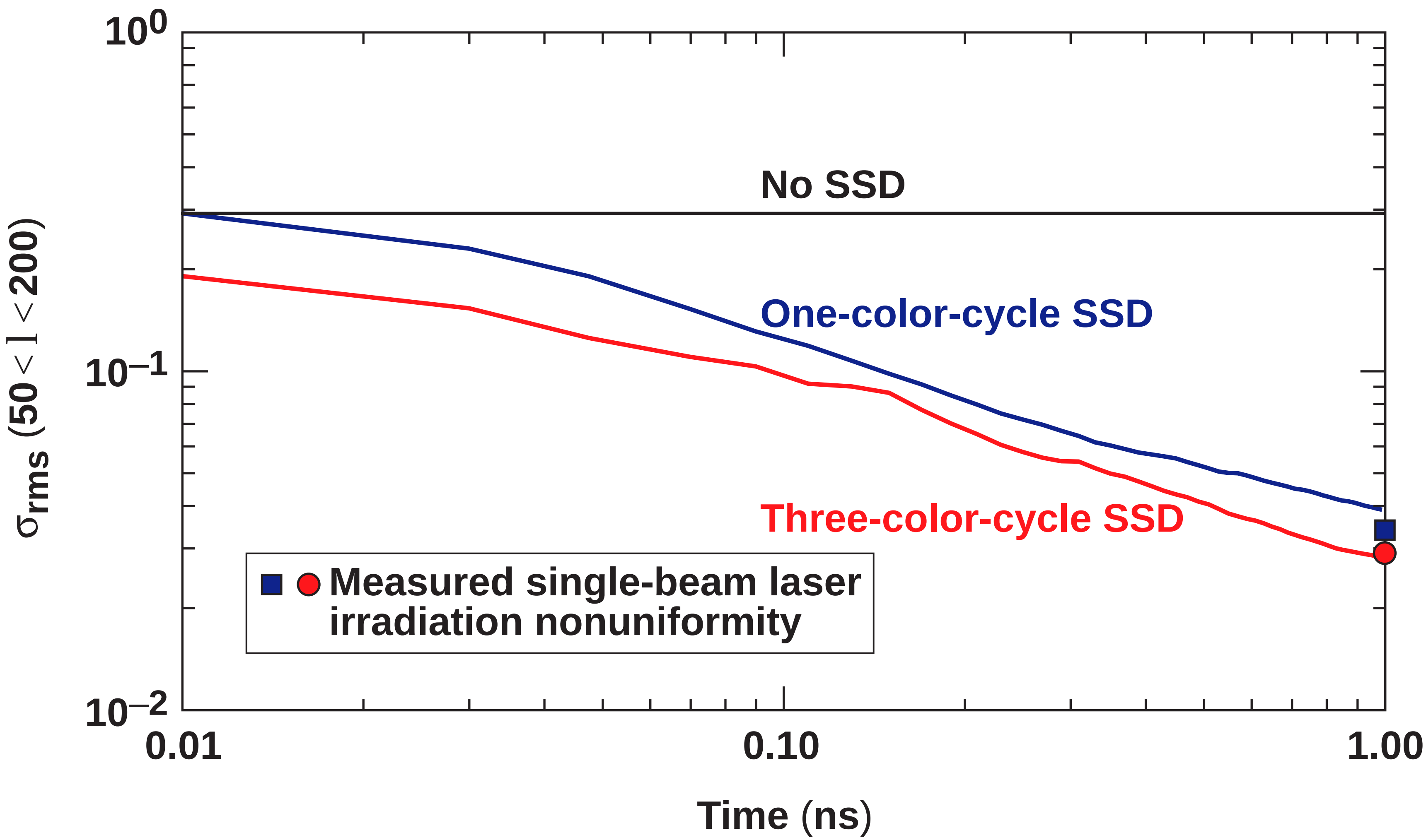
Laser irradiation nonuniformity for $50 < l < 200$ is similar for one-color-cycle SSD and three-color-cycle SSD



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Capsules irradiated with one-color-cycle SSD and with three-color-cycle SSD have similar burnthrough

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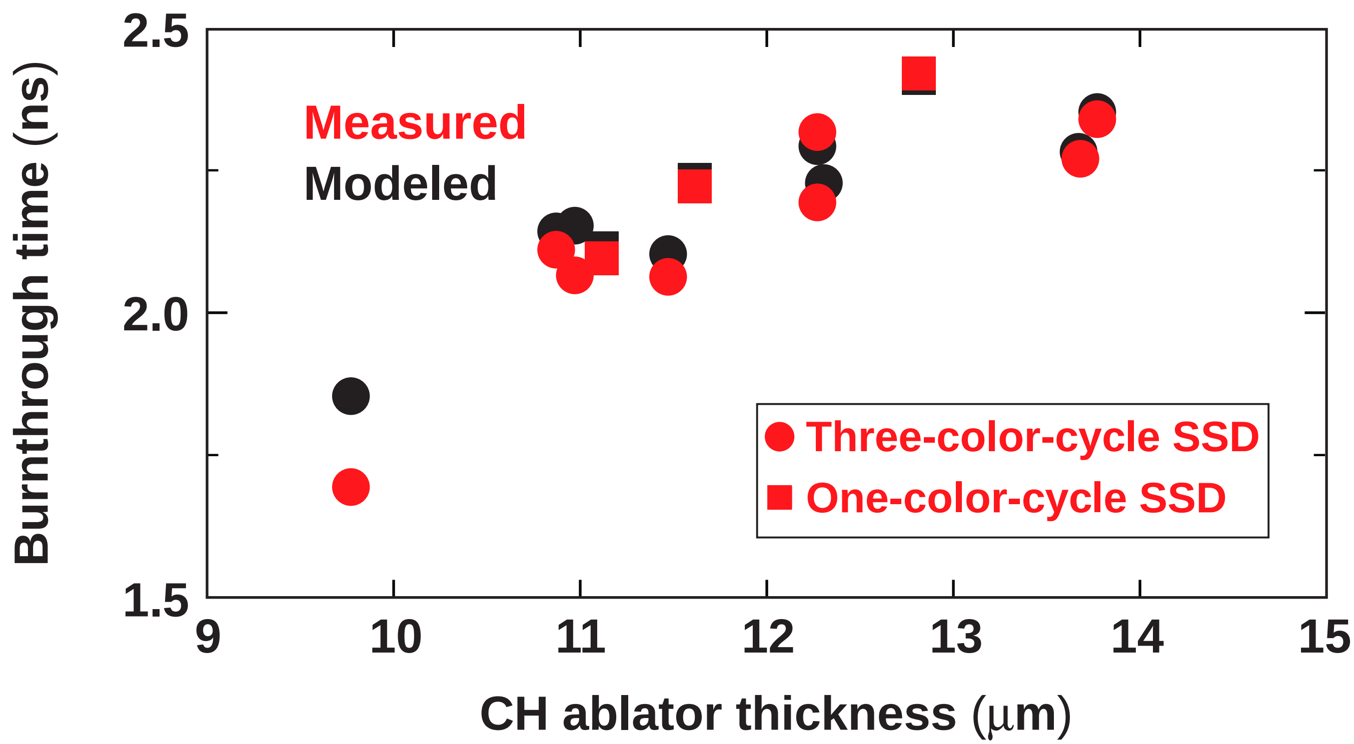
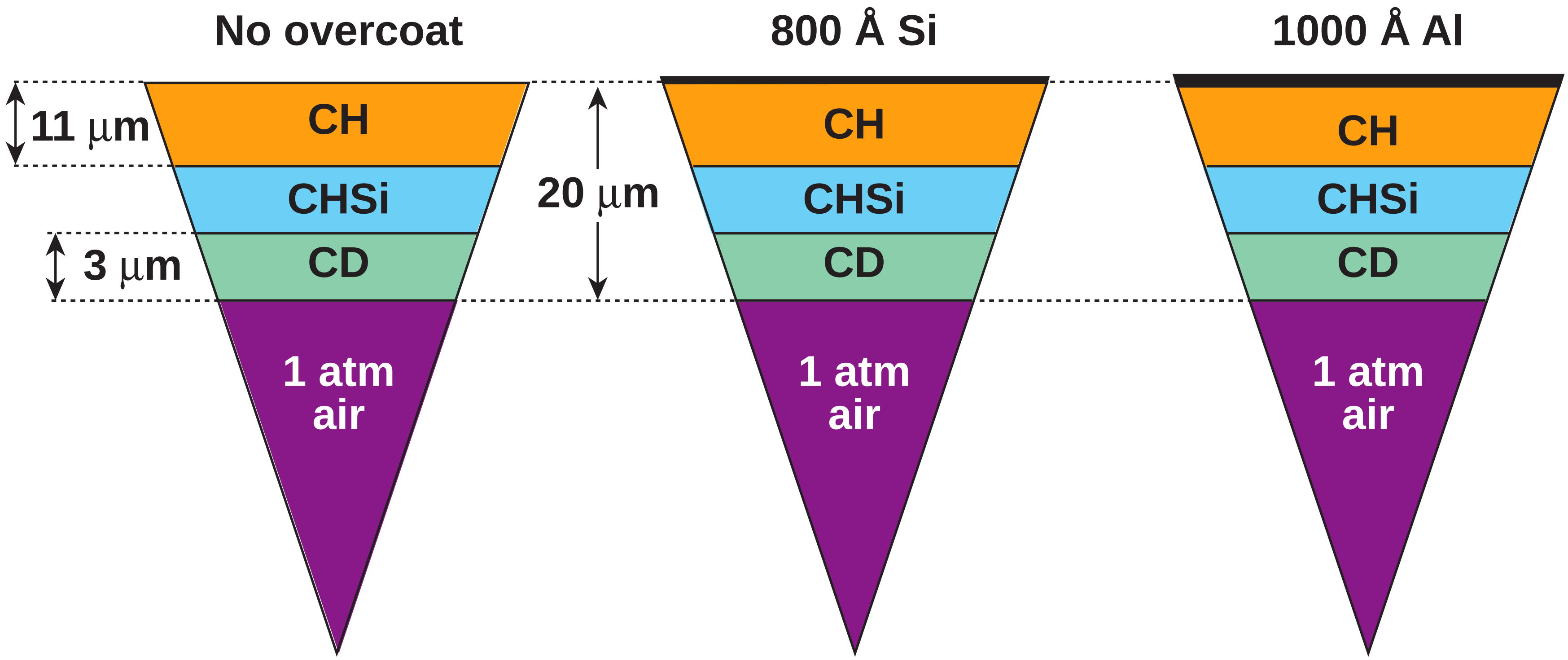
- All modeled points use the same initial laser imprint.



Burnthrough is consistent with single-beam laser irradiation nonuniformity measurements.

E10121

Effects of the shinethrough layer on the target performance of plastic capsules were examined

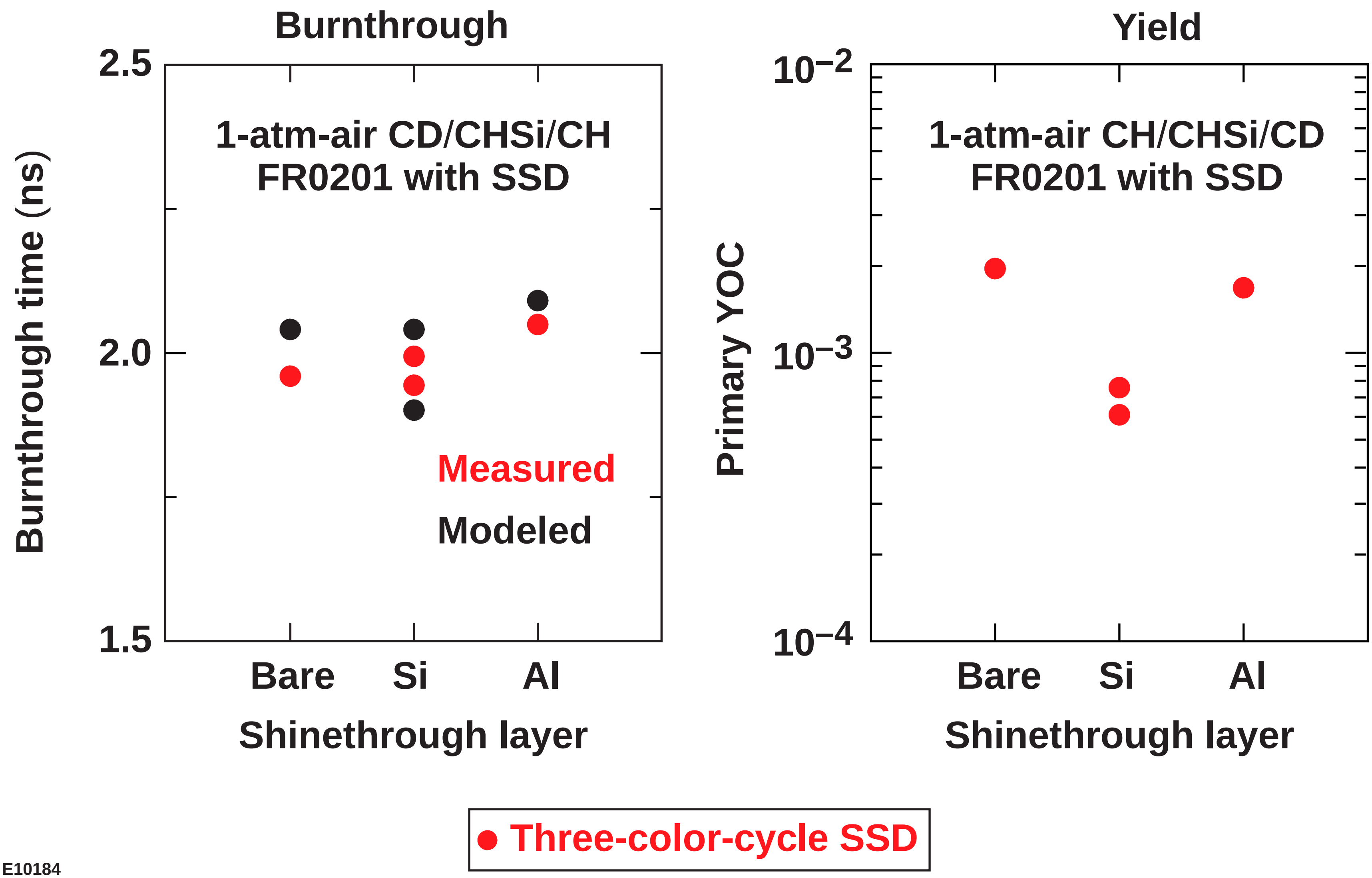


Previous results:
The Al shinethrough layer delays burnthrough in glass (CH/SiO_2) capsules.*

*J. Delettrez *et al.*, Phys. Rev. A 41, 5583 (1990).

E10189

Shinethrough layers on plastic capsules do not affect the burnthrough in a significant manner



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Summary/Conclusion

Burnthrough experiments probe the Rayleigh–Taylor instability in direct-drive implosions

- **Capsules irradiated with three-color-cycle, 2-D SSD have similar burnthrough to those irradiated with one-color-cycle, 2-D SSD.**
- **Shinethrough layers on plastic capsules do not affect the burnthrough in a significant manner for the three cases studied: 1000 Å of Al, 800 Å of Si, or no overcoat.**